Virginia Tech
College of Engineering

Joseph F. Ware, Jr. Advanced Engineering Lab
Policy Manual

For Academic Year 2012-13

This policy manual serves the purpose of providing a comprehensive document containing rules and regulations for the proper use of the Joseph F. Ware, Jr. Advanced Engineering Laboratory (aka *Ware Lab*) including all materials, equipment, and resources contained herein.

All Ware Lab student team members, participating faculty advisors, and lab employees are required to have a copy of this manual in paper or electronic format and to be familiar with its contents.

Teams or groups working at Ware Lab from other schools, universities, or organizations must receive a copy of this policy manual in paper or electronic form and be familiar with its contents. Visiting teams or groups must receive permission from the Ware Lab manager prior to working in this facility. Distribution of this policy manual to visiting teams or groups is the responsibility of the hosting Virginia Tech Ware Lab team.

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Introduction

The Joseph F Ware, Jr. Advanced Engineering Lab at Virginia Tech (aka *Ware Lab*) is divided into four work/administrative areas, each requiring varying levels of safety certification. These areas include:

1. General Areas
    a) First floor – (Figure 1 - Rooms 100, 104, 106 through 114, 117, B1, B5, B6, CR-1)
    b) Basement – (Figure 2 – Room 18)
2. Machine Shop – (Figure 1 - Room 101)
3. Welding Shop – (Figure 1 - Room 102)
4. Administrative Areas – (Figure 1 - Rooms 101A, 101AA, 103, 105, B2, B3, B4).

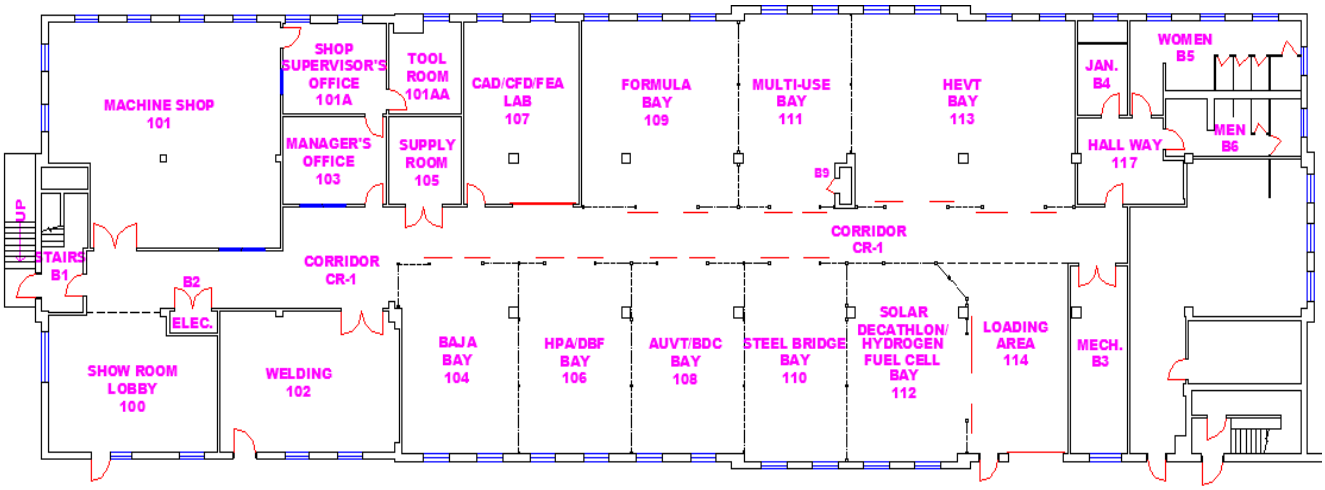

Figure 1 - Ware Lab First Floor

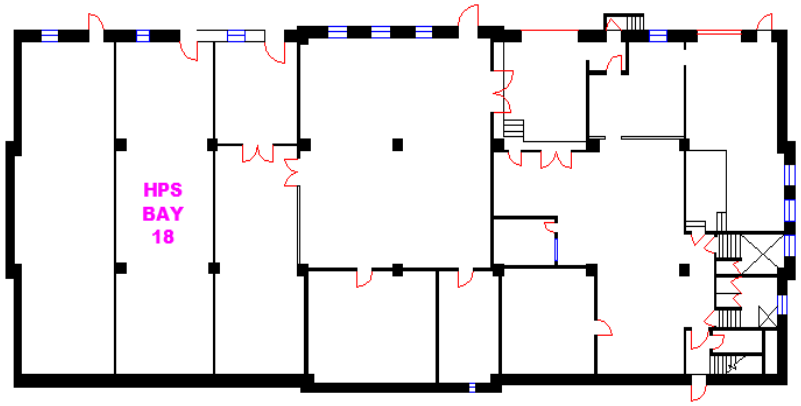

Figure 2 - Ware Lab Basement

This document specifies rules pertaining to each area shown in Figures 1 and 2 along with regulations applying to all areas. In addition, rules pertaining to the proper use of Ware Lab equipment, such as the project truck and trailers, fork lift, and golf cart are also included. Ware Lab is the only undergraduate facility on campus with 24/7/365 access and having access to this lab is a **privilege**, not a right.

Section 1 - Access to Ware Lab

1. General Areas:

Ware Lab's general areas are open to properly certified members of the Virginia Tech community 24 hours a day, seven days a week, and 365 days a year. Ware Lab is a secure facility equipped with surveillance cameras with activity being continuously recorded. Lab access is limited to Virginia Tech students, staff, and faculty who, needing space to conduct project related work, meet the following requirements:

A. They must be a current student, staff, or faculty member of Virginia Tech.

B. Students must pass a general safety quiz administered via the Scholar course management system.

C. Students must be active members of an undergraduate student project within the college of engineering and must be approved by a Virginia Tech engineering faculty member for admission.

D. Students must display current photo badges on the outside of their project bay while certified to be in Ware Lab. Photo badges are available from the Virginia Tech Hokie Passport office during operating hours.

Not all undergraduate engineering projects are conducted in Ware Lab. Only students participating in an approved project can work in Ware Lab. For a list of approved projects visit the Ware Lab web site at http://www.eng.vt.edu/warelab/.

Ware Lab visiting hours are from 9 am to 4 pm, Monday through Friday. During these times guests invited by Ware Lab teams may visit the lab for work related purposes specific to team projects. Groups wanting to tour the facility may also visit at this time. Tours are approved and conducted by the Ware Lab manager. In some cases, a Ware Lab work study may conduct a tour if the manager is not available.

Long term student, staff, or faculty parking in the near vicinity of Ware Lab is not permitted at any time. Thirty (30) minute loading passes are available to teams from the Ware Lab manager on a first-come, first –serve basis only for the purpose of loading and unloading project material and equipment. These badges expire at the end of each Summer II academic session. See Section 11 for more details about parking at the Ware Lab.

Occasionally, teams from other universities and colleges visit Ware Lab to work with Virginia Tech teams. These visitors are required to be familiar with, and comply to, all polices specified in this manual.

Visitors to Ware Lab need to go to:

http://www.facilities.vt.edu/tcs/parking/visitors.asp

to obtain proper temporary parking permits while on the Virginia Tech campus.

No hot work (welding, acetylene torch cutting, etc.) is to be done in the project bays without getting a temporary "hot work permit" from the shop supervisor. During hot work operations, protective shielding (red transparent partitions) MUST be used to prevent persons passing the bay and others working in the bay from receiving eye and/or burning injuries.

2. **Machine Shop:**

Unlike the general areas, the machine shop is **not** open 24 hours a day. The machine shop door is unlocked from is 8 am to 5 pm, Monday through Friday. Students using the shop during these hours do not need to use their Hokie Passport cards for access but **must still** be properly machine shop certified for entry.

After 5 pm and until 11 pm, Monday through Friday, students with proper machine shop certification may access the shop using their passport cards. Card access is required from 8 am to 11 pm on weekends.

After 11 pm and until 8 am of the following day the machine shop **is closed**. Entry during this time can be granted only by the Ware Lab manager. Students gaining access to the machine shop when it is closed **must be accompanied by their Ware Lab project faculty advisor during their entire time they are in the shop.** Students needing access during this time must contact the Ware Lab manager and their team faculty advisor prior to admission. They must also sign an additional waiver form specifically for the purpose of after-hour machine shop admission. Access during these hours are granted for extreme cases and only when accompanied by the faculty advisor**. Students found to be in the machine shop between the hours of 11 pm to 8 am of the following day without being accompanied by their faculty advisor, without prior approval of the Ware Lab manager, and without signing the special waiver form will permanently lose their access privileges to the machine shop and the Ware Lab facility.**

Machine shop doors are not to be propped open after 5 pm. Doing so activates alarms at the Hokie Passport office. If doors need to be temporary propped to load or unload equipment and materials contact the Ware Lab manager ahead of time so Hokie Passport can be notified. Also, when the secondary door (door without knob) is not in use, its top AND bottom latches MUST be in their locked position. This allows the primary door to properly lock when closed. Always make sure that the primary door completely closes to prevent accessing the machine shop without having to swipe a passport card.

3. Welding Shop:

Similar to the general work areas, the welding shop is open 24 hours a day. The welding shop door is unlocked from 8 am to 5 pm, Monday through Friday. Students using the shop during these hours do not need to use their Hokie Passport cards for access but **must** still be properly weld shop certified for entry.

After 5 pm and until 8 am of the following day, Monday through Friday, students with proper welding shop certification may access the welding shop using their passport cards. Card access is required 24 hours per day on weekends.

Welding shop doors are not to be propped open after 5 pm. Doing so activates alarms at the Hokie Passport office. If doors need to be temporary propped to load or unload equipment and materials contact the Ware Lab manager ahead of time so Hokie Passport can be notified. Also, when the secondary door (door without knob) is not in use, its top AND bottom latches MUST be in their locked position. This allows the primary door to properly lock when closed. Always make sure that the primary door completely closes to prevent accessing the welding shop without having to swipe a passport card.

4. Administrative Areas:

Students are not allowed into administrative areas without being accompanied by a Virginia Tech staff or faculty member. As a courtesy, students must knock before entering administrative office areas.

Section 2 - Ware Lab Safety Certifications

The procedures below must be following for students working on Ware Lab projects and needing access to the Ware Lab facility. Failure to follow these procedures will result in loss of Ware Lab access privileges.

1. **General Areas:**

   Obtain a minimum score of 85/100 on the **general lab safety quiz** posted on Scholar. Instructions for finding the Ware Lab quizzes in Scholar are on the *Online Safety Quizzes* tab on the left hand side of the Ware Lab website at:

   http://www.eng.vt.edu/warelab/

A. once you pass the general quiz with an 85/100 or better you need to complete the Ware Lab admissions survey found at…

   https://survey.vt.edu/survey/entry.jsp?id=1345839411765

   Use your valid Virginia Tech PID and PW to log into the survey. The survey link is opened during the first week of each Fall semester.

C. Once you finish taking the survey, print out the waiver form (shown at the beginning of the survey), sign and date it, and turn it into the Hokie Passport office. There you will get a new Ware Lab badge.

D. The badge must be visible from the front of your project bay. The cost of the badge is $5.00. There is no charge if you give Passport your old badge. Permission to enter Ware Lab is granted **after** you have signed the waiver form and obtained a badge from Hokie Passport.

2. **Machine Shop:**

A. Complete all requirements for admission to the general area per **Section 2.1**.
B. Obtain a minimum final grade of *B*+ in ISE 2214 *Manufacturing Processes Laboratory*.
C. Obtain a minimum score of 85/100 on the machine shop safety quiz posted on Scholar.
D. Complete and pass the milling and lathe parts of the shop supervisor's in-shop machine course. Each part takes about 1.5 hours to compete. **Note:**

i. Ware Lab shop classes are offered **ONLY DURING FALL SEMESTER!**

ii. In order to be placed on the schedule for machine shop training, you must provide the completed Ware Lab Machine Shop Training Request Form (available in the Resources section on Scholar) to the Shop Supervisor.
iii. Classes are conducted on Tuesdays, Wednesdays, and Fridays starting at 1pm.
iv. Each team gets 4 to 5 slots, after that it's first-come, first-serve
v. No-shows with be allowed a second chance only if there are excruciating circumstances for being absent.
vi. If you cannot make it to a shop class inform the Ware Lab Shop Supervisor by email (harold9000@vt.edu) before class.
vii. You must show your Ware Lab badge (current for that year) to the shop supervisor on the first day of class.
viii. Once the machine shop class is completed, you will receive a signed certification card from the shop supervisor
ix. You must complete both the milling and lathe samples during the same training period.

E. When items A through D are met, the Shop Supervisor will email the lab manager your name, and student ID, and indicate that you have completed the *machine shop requirements* in the body of the email. The Lab Manager will request door access to the machine shop for you. Allow one week for this process to be completed. Inform your team leader and faculty advisor to keep them in the loop.

3. Welding Shop:

A. Complete all requirements for admission to the general area per **Section 2.1**.
B. Have your name added to a list compiled by the instructor of BSE 3494 *Advanced Welding Technology* indicating that you have completed the course in a satisfactory manner.
C. Obtain a minimum score of 85/100 on the welding shop safety quiz posted on Scholar.
D. Have the Ware Lab Manager or Shop Supervisor sign a card certifying student has passed BSE 3494 and the welding safety quiz.
E. When items A through D are met, email spangler@vt.edu your name, student ID, and indicate that you have completed the *welding shop requirements* in the body of the email.

Section 3 - Proper Use of Ware Lab Facility

1. Personal Protective Equipment and the Buddy System:

Appropriate personal protective equipment (PPE) must be worn when working in the Ware Lab. Students not wearing appropriate PPE will not be allowed lab access. Note: this applies to all areas in the lab **including** project bay areas. Close toed shoes ("street shoes") are **required** in the machine shop. This includes tennis shoes, boots, etc. which are in good condition. Leather shoes are required when using welding equipment. In the project bays **street shoes are strongly required as well when running high speed powered equipment**. If your team does not have the appropriate PPE for a specific procedure, contact the Ware Lab Manager or Shop Supervisor to obtain necessary safety gear.

Utilize the *buddy system* at all times. This means that, when powered equipment is being utilized, a minimum of two people should be working in the general Ware Lab area, in the HPA bay~~,~~ or in the welding shop at any time. It is advised that when only a two or three people are working in the general lab area that periodic visual contact be maintained in case someone becomes seriously injured and is unable to contact emergency medical personal on their own. A minimum of two persons are to be in the machine shop when any high speed rotating equipment is being used. All CNC and other automated machining equipment are to remain manned during powered operation.

Under no circumstances may powered equipment with high speed moving parts be brought into ANY area of the Ware Lab without prior permission of the shop supervisor and lab manager. All persons using power equipment in the lab must be trained by the shop supervisor prior to use.

2. Safety Glasses:

Safety glasses are **REQUIRED** in the machine and welding shop areas at **ALL** times. In the project bays safety glasses must be worn when working with any type of power equipment. Safety glasses and face shields must be worn during grinding, sanding and polishing operations for all materials. Failure to do so may result in eye irritation, embedded metal/wood shavings, and blindness.

If particles get into eyes flush at eye wash station for 15 min. If you need safety glasses for a particular task the Ware Lab manager or shop supervisor will provide them to you.

3. Gloves:

The same glove is NOT suitable for all applications. For example, disposable latex gloves will protect you while handling fiberglass but will NOT protect you from certain chemicals.

Use the follow glove *types* when working with the following *chemicals*:

A. Neoprene gloves for epoxies.
B. Butyl gloves for acetone.
C. Nitrile gloves for gasoline and resin systems.

Gloves are available in the plastic cabinet in the CAD/CFD/FEA Lab – if any of the bins are empty contact the Ware Lab manager or shop supervisor. For more information on using the correct glove for a give application and chemical go to:

www.bestglove.com

4. Respirators:

Any respiratory protection being used by a student or worker in the Ware Lab must be approved by Virginia Tech's Environmental Health and Safety (EHS). Use of a nuisance dust mask does not require approval from EHS. Nuisance masks do not have a NIOSH approval number and are not referenced as a "respirator". A respirator, for example, has an *N-95, P-100* face mask designation. These masks are considered "respirators" since they are subject to compliance with OSHA's Respiratory Protection Standard. The use of a respirator at the Ware Lab requires the following steps:

A. A respiratory medical evaluation questionnaire must be completed and submitted to EHS. The questionnaire is located at www.ehs.vt.edu . Click on *Online Forms* in the left frame, go down to *Other Forms*, and click *Respirator User Medical History Questionnaire*. Send the questionnaire to respirators@vt.edu for review.

B. Recommended enrollment in the EHS Voluntary User Program. This program involves the review of Appendix D of OSHA Respiratory Protection Std. 29 CFR 1910.134, and acknowledgment of that review by signature on an Informed Consent Form submitted to EHS.

C. Registration for an EHS one-hour respirator training class can be accessed on line by going to www.ehs.vt.edu, clicking on *Training*, then *Class Schedule and Registration*, scrolling down to *Respiratory Protection* and selecting a class date and time.

D. ANY student or employee needing a respirator must be fit tested to ensure that the particular respirator is providing a proper seal. This fit testing will not be completed until the one-hour training class has been taken. Students and employees must check the training schedule on line and contact the medical surveillance coordinator to schedule an appointment. EHS is located on the Virginia Tech campus at:

Virginia Tech, Environmental Health & Safety Services
459 Tech Center Drive
Blacksburg, Virginia 24061

Note: Filter cartridges used with respirators are selected by EHS based on exposure level. When a cartridge needs replacement, it should be replaced with the same cartridge recommended by EHS. Old cartridges and respirators that have not been properly cleaned and maintained must be discarded and replaced. All functioning half-face respirators must be cleaned after each use and kept in a sealable plastic container or zip-lock bag. If respirators are needed in the machine shop, discuss this with the Ware Lab manager or the shop supervisor so that the procedure to be conducted can be evaluated.

5. **Hearing Protection:**

Ear plugs and/or ear muffs are recommended in areas where noise-producing power tools or machinery are used. If you are within 3 feet of someone and need to raise your voice to communicate, it is possible that you are in a hazardous noise area and should be using hearing protection. **Hearing loss is permanent!** Disposable ear plugs are available in the machine shop for any student certified to work in any of the Ware Lab areas. You may enter the machine shop (while wearing eye goggles) for the purpose of obtaining hearing protection without being machine shop certified. You must leave the machine shop area once you have obtained ear plugs. If the ear plug bin is empty, inform the Ware Lab manager or shop supervisor immediately. The bin is located on the right wall as you enter the machine shop.

6. **First Aid Kits, Fire Extinguishers, Eye Wash/Shower Stations:**

First aid kits and fire extinguishers are located in the main hallway and both shop areas. First aid kits and fire extinguishers are not to be blocked. If blocked, move material to at least three feet directly away from the front of the kit or extinguisher. If a first aid kit is missing items or a fire extinguisher needs refilling inform the Ware Lab manager or shop supervisor immediately.

One eye wash/shower station is located near the restrooms on the first floor of the lab and another is located in front of the enclosed stall area in the Human Powered Sub bay. Stations are not to be blocked. If blocked, move material to at least three feet directly away from the front of the station. A clip board is located near each wash station with a sign-in sheet. Every two weeks the sink should be run for about 4 seconds to clear out any particulate or dust. Please run the sink and fill in the appropriate information on the sign-in sheet if the sink has not been checked for more than two weeks. **Please DO NOT check the shower due to the mess created!**

7. **Material Safety Data Sheets (MSDS):**

According to Environmental Health and Safety (EHS):

> Chemical manufacturers and importers must evaluate their products to determine if they are hazardous. If they are considered to be hazardous, a Material Safety Data Sheet (MSDS) must be prepared and sent to end users. It is essential that the end user have access to the information and become familiar with the hazards prior to working with the substance. Each department or work area must maintain a MSDS for each hazardous chemical (or product) they use.

Therefore, Material Safety Data Sheets (MSDS's) are to be maintained on Scholar (in the Resources section) for all hazardous materials used in the Ware Lab by any team. If you bring a hazardous chemical (or other hazardous product) into the Ware Lab, it is your responsibility to ensure that a MSDS for that material is available on Scholar. If it is not, you MUST acquire one (in PDF, preferably) and provide it to the shop supervisor prior to bringing the material into the building. Additionally, you must first receive the approval from the Ware Lab manager before bringing any new chemicals into the Ware Lab.

Before using any hazardous material, you should review the MSDS for that item. For more information on reading a MSDS, please refer to:

http://www.ehs.vt.edu/programs/HCM_MSDS_info.php

A backup copy of the MSDS library is also maintained in paper form at the Safety Station in the Ware CAD/CFD/FEA Lab. Please do not remove these sheets from this station. If you need a paper copy, print one from Scholar (or if Scholar is not available, make a copy and **return the original to the safety station**).

8. **Hazard Control**:

Equipment guards are designed to keep the user safe during machine operation and should not be in an un-protective position or removed anytime the machine is running. Adjusting guards away from their protective position or removing them while a machine is running will result in permanent loss of Ware Lab access privileges.

9. **House Keeping:**

Project bays, the machine shop, the welding shop, hallways, the loading area, and restrooms are to be keep clean at all times. Spills are to be cleaned off of the floor immediately to prevent slipping hazards.

Emergency exits, fire extinguishers, and emergency cut-off switches must have unobstructed access at all times. No material is to be stored above the lowest point of the sprinkler system in the ceiling. Compressed gas cylinders must be in a vertical position and secured at all times.

All flammable substances must be stored in the flame retardant (yellow) cabinet located in each bay. Excess amounts of these substances must be disposed of in the proper container located outside of the back garage door on the first floor of Ware Lab. If the container is full contact the Ware Lab Manager or Shop Supervisor immediately. Place empty oil cans in a trash can, NOT in the shelter itself.

Grinders and drill presses located in project bays must be plugged into a wall outlet or a single connect extension cord, **NOT** into power strips. Computers, lighting, and other common electrical devices in project bays may be plugged into power strips **with adequate surge protection.** Electrical drop cords may be connected to a power strip, but only during use of that particular device. In short, these devices must be unplugged after use. **No daisy chaining of power strips are allowed under any circumstance anywhere in the Ware Lab due to the potential fire hazard created.**

Computers in the CAD/CFD/FEA lab **must** be directly plugged into a wall outlet. Printers, monitors, and other electrical peripherals may be plugged into power strips with adequate surge protection.

If any Ware Lab equipment has frayed electrical cords, ask the Ware Lab manager or shop supervisor for a repair or a replacement. Equipment owned by teams with frayed electrical cords must be repaired or replaced by the individual team.

Team members are responsible for taking out the trash in the project bay area. A dumpster is located in the parking lot beside Shanks Hall and near the gated entrance to the Power Plant on Barger Street. Food is not to be left open to the air overnight anywhere in the Ware Lab to prevent offensive smells and prevent attracting insects and rodents.

10. Worker's Actions:

The following are safeguarding aids that must be followed during the use of any machine or powered equipment in Ware Lab:

- **A.** Holding tools – use to place and remove material to reduce point of operation hazard (e.g.: pliers, appropriate gloves).
- **B.** Push blocks – use to feed material into cutting blades to keep hands farther away from point of operation.
- **C.** Warning signs – read before using any machine; they inform the user of the guards that are available and their proper use.
- **D.** ON/OFF switches - turn machinery **off before** leaving work area.

11. Mechanical Motion:

Hair and clothing can easily become entangled in machinery with moving parts. Rotating machine motion (circular motion) can cause scalping, amputation, and choking (e.g.: grinders). Reciprocating machine motion (back/forth or up/down motion) can

cause amputation or other injuries (e.g.: saber saws). Transverse machine motion (straight, continuous line motion) can result in impact or other hazards (e.g.: Kalamazoo device).

12. Point-of-Operation Hazards:

Points of operation occur where material (work piece) and machine meet. In short, where work is being done on a part or component. Cutting (mechanical motions), punching (blanking, drawing, stamping), shearing (slide or knife), and bending have multiple point-of-operation hazards. Injuries due to point-of-operation hazards happen most often when **worker is not paying attention.**

These can be prevented by proper use of guards, proper operation of machinery, and attentive worker attitude.

13. Ware Lab Ventilation:

Additional ventilation is necessary for:

- welding
- grinding
- sanding
- cutting carbon fiber
- applying epoxy

The general area of the first floor of Ware Lab does not have adequate indoor ventilation for these activities, except in the welding shop. If your team needs to perform any of the tasks listed above (except welding) they must be performed outside in the back of Ware Lab in the area next to the garage door. If the activity does not produce excessive odor it may be done in the project bay **IF** a box fan is placed in the window near the work area. If the activity results in the production of any harmful fume or gas, or any offensive odor it MUST to be done outside. All welding **MUST** be performed in the welding shop and ONLY by persons certified to use welding equipment per Section 2.3. See Section 3.14 for more on welding shop ventilation.

The entire first floor of Ware Lab does **not** have proper ventilation for painting or performing fiberglass work. Therefore all painting and fiberglass sanding must be done in the area outside of the rear garage door. **Plastic or cardboard must be placed on the concrete prior to painting and performing fiberglass work.** Consult with the Ware Lab manager before doing this type of work anywhere inside of the first floor of the Ware Lab. Failure to do so will result in loss of access privileges.

The Human Powered Sub (HPS) bay in the basement of Ware Lab has a special enclosed area that is properly ventilated for fiberglass work. Painting cannot occur since the area is not properly ventilated for this type of work. This special area is limited to HPS team members only. During fiberglass sanding operations EHS strongly recommends that HPS team members wear clean TYVEK full body suits. EHS further

recommends that a new TYVEK suit be worn each time a sanding operation is conducted. TYVEK suits are available from various on-line venders and must be purchased using individual team funds.

14. Welding Shop Ventilation:

During any welding process the HVAC, ventilation system, and fan above the rear door must be turned on. During any plasma cutting process the HVAC must be turned on. Metal fume fever can result if proper ventilation is not being used during welding and plasma cutting activities. The interior double doors of the welding shop are NOT to be propped open at any time. If, and only if, the welding lab area becomes excessively hot, the external door may be propped open for the purpose of cooling the area. All ventilation must be engaged to attempt to cool the area first prior to propping the door open.

Only persons with certified welding access are allowed to prop open the door and they or someone with at least general Ware Lab safety certification must remain in the welding area the entire time door is open. **Under no circumstances is anyone allowed in the welding lab who is not Ware Lab safety certified**.

Note: acute and chronic health hazards are associated with welding and cutting operations. These include infertility, lung cancer, head ache, nausea, and muscle pain.

Review the appropriate MSDS for metals, fluxes, welding rods, and gases that are being used for more information on health precautions related to these substances located at the safety station in the Ware CAD Lab.

Section 4 - Ware Lab Vehicle Safety Certifications

Ware Lab has a truck, open trailer, and closed trailer available to teams for attending competitions, transporting heavy equipment and materials, and attending public relation events. The truck and/or trailers are not to be used to run errands that can be accomplished with the use of personal vehicles.

1. **Truck and Open Trailer Certification:**

Each Ware Lab team member needing to drive the Ware Lab truck and/or open trailer must complete a sign-out sheet and submit an FS-2 form (http://www.facilities.vt.edu/documents/ot/FS-2.pdf) along with a copy of a valid state driver's license to the Ware Lab manager. Only members who have Ware Lab general safety certification may use the truck or open trailer and permission to use these items must be obtained from the Ware Lab manager or shop supervisor prior to use. Smoking is prohibited in the Ware Lab truck and in all state vehicles.

Prior to using the truck or open trailer a thorough "walk-around" visual inspection **must be conducted** by the driver(s). Any dents, scratches, or damaged or missing parts must be written down on a clean sheet of paper and turned into the Ware Lab manager prior to travel. Any damage to the truck or open trailer that occurs during its use must be reported immediately to the Ware Lab manager or shop supervisor.

Fuel expenses associated with operation of the truck must be covered by team funds. Ware Lab cannot reimburse teams for fuel expenses unless the trip is associated with a Ware Lab public event and the trip is preapproved by the Ware Lab manager.

If you, or a fellow team mate, are involved in an accident while using the Ware Lab truck, you **must** fill out the forms contained in the truck's glove box. On the back of the envelope containing the forms is contact information for State Police emergency numbers categorized by cellular, administrative headquarters, emergence TDD and state division (1 thought 7).

Anyone found driving the truck recklessly or driving it while under the influence will permanently lose driving privileges, and the entire team may be penalized, at the discretion of the Ware Lab Manager.

2. **Closed Trailer Certification:**

In order to operate the Ware Lab closed trailer (Baker Hughes trailer) proper training from the shop supervisor **must** be obtained. Any team member who operates the closed trailer without proper certification will permanently lose Ware Lab access privileges. The closed Ware Lab trailer can only be used when attached to the Ware Lab truck. All electrical devices on the closed trailer must be turned off after use to prevent battery drainage.

Due to the size of this trailer, a spotter must accompany any student driver to assist in traffic control and backing in case that becomes necessary. No student may pull the closed trailer without being accompanied by a spotter.

Prior to using the closed trailer a thorough “walk-around” visual inspection must be conducted by the driver(s). Any dents, scratches, or damaged or missing parts must be written down and turned into the Ware Lab manager. Any damage to the closed trailer that occurs during its use must be reported immediately to the Ware Lab manager or shop supervisor.

Section 5 - Proper Code of Conduct

1. Reckless behavior such as horse play, throwing objects, etc. is not allowed in any area of the Ware Lab.
2. Loose clothing, jewelry, neckties, and scarves should not be worn in the Ware Lab machine and welding shop areas or while working with power equipment in the project bay.
3. Long hair must be confined and tied back behind the head and long facial hair must be covered while using power equipment of any type.
4. Do not leave project related items in the hallway for an extended period of time. Remove them as soon as possible.
5. No personal bikes or cars are allowed in the Ware Lab at any time.
6. No personal projects are to be conducted in the Ware Lab at any time.
7. No food or drinks are allowed in the machine or welding shops.
8. Do not place an order on any Ware lab account without first receiving permission from the Ware Lab manager.
9. Radios and stereos are to be kept at a low volume and bass level. If volume and base levels are not keep low radios will be required to be turned off as a first offence, will be required to be removed from the lab as a second offence, or will confiscated as a third offence.
10. Reframe from using offensive language.
11. Pornographic or other offensive materials are not to be downloaded or viewed on any computer located in the Ware Lab facility.
12. Remove snow and/or excessive mud off of any project vehicle prior to bringing into Ware Lab.
13. Fellow team members, Ware Lab staff, other Virginia Tech employees, and visitors to the lab are to be treated with respect and courtesy at all times. Rude or arrogant behavior towards others will not be tolerated.
14. Visually inspect rechargeable battery packs in the lab before use. If there is any sign of damage or overheating dispose of or recycle the charger. See the article *Battery Pack Catastrophic Failure During Charging* pdf article posted on Scholar with this policy manual.
15. The CAD/CFD/FEA lab have specific rules posted on each wall of the facility. These rules are:

    A. Do not unplug any computers or equipment from surge protectors.

    B. Do not plug computers to extension cords that are not connected to surge protectors. Power surges could cause severe damage if this is done.

    C. Do not remove ANY equipment from the CAD Lab area. This includes mice, monitors, tracking balls, etc. Items removed from the lab are replaced with money that partially comes from stipends given to Ware Lab teams each fall semester.

D. If you spill something on the floor or on the table or under a computer PLEASE **CLEAN IT UP!**

E. Place drink and food containers in the trash can **when you are finished eating**. Eating and drinking are privileges in the lab, not rights.

F. DO NOT disconnect systems and move keyboards/mice/etc. between computers. Do not cut cable ties. They are place there for a reason. Constant tugging or unplugging and plugging the ether-net cables breaks the clips so the cables do not stay connected properly.

G. Keep tables and the book shelf clean and in a neat condition. Visitors to the lab can clearly see during tours!

H. DO NOT print out class related work on the printer or plotter except those items related to group Ware Lab team reports or posters; in short, no individual class assignments, tests, exams, reports, etc.

The Ware CAD lab gets a lot of use from multiple teams**. IT IS A PRIVILEGE TO HAVE THIS SPACE AVAILIBLE, NOT A RIGHT!** Please use the space according to common sense and the rules listed above. Our IT people have huge workloads so they can only service problems on a part time basis!

Section 6 – Potential Machine Shop Hazards

1. **Potential Injuries:**

    A. scalping (due to hair getting caught in moving machinery)
    B. loss of fingers (coming into contact with any cutting or shearing machinery)
    C. bruising
    D. cuts
    E. burns

2. **Severe Injuries:**

    A. amputations
    B. lacerations
    C. eye injuries
    D. punctures
    E. shock

3. **Impact Hazards:**

An impact hazard is caused by flying debris or by reciprocating high speed machinery and can results in:

A. bruising
B. broken skin
C. loss of eyesight
D. broken bones

Examples of impact hazards include:

A. grinder throwing work piece due to being incorrectly secured.
B. Leaving chuck key in lathe. **This has been known to leave a mark on concrete 30 ft away!**
C. Not securely clamping work piece on mill or lathe resulting in part flying across room.
D. Placing objects where they may fall into a fast turning part on the lathe.

4. **Entanglement Hazards:**

Most machines in the machine shop use rotating motion. Rotating parts can instantly catch loose clothing, hair, and jewelry and cause:

A. amputations
B. scalping
C. chocking/asphyxiation
D. cuts and scrapes

5. <u>Sharp Object Hazards</u>:

Blades and drill bits have sharp edges. Proper handling of bits and blades is necessary to avoid:

A. cuts
B. punctures
C. loss of fingers

Carefully follow directions on band saw(s) while installing new blades. Use proper chuck size for mill and lathe to avoid injuries and parts with poor tolerances.

6. <u>Hazardous Areas for Injuries due to Physical Contact:</u>

These include:

A. Nip Points: parts on parallel axes that rotate in opposite directions or against stationary objects (most common). **Examples:** English wheel, chain and sprocket, contacting gears or pulleys.
B. Shear Points: cutting blade moves past a stationary point. **Example:** shearing machine.
C. Pinch Points: body parts can be caught between moving and/or stationary parts. **Examples:** English wheel, lathe, mill.
D. Point of Operation: area on machine where work is being done. **Examples:** contact point between drill tip and work piece.
E. Power Transmission Equipment: all parts that transmit energy and motion. **Examples:** gears, cams, pulleys, belts, clutches, rods.

7. <u>Injuries due to Potential (Stored) Energy:</u>

Potential, or stored, energy is dangerous because the **<u>impending motions are sudden and not</u>** expected! Carefully examine lockout/tag-out procedures to prevent injuries from accidental start up or unexpected energizing.

A. Unexpected start-up of machinery **Examples:** during computer numeric control (CNC) processes.
B. Hydraulic/pneumatic and electrical energy release. **Examples:** hydraulic presses, Kalamazoo device, grinders, band-saws.
C. Wires or cables under high tension. **Examples:** “Come-a-longs”, pulleys.
D. Frayed or damaged electrical cords due to presence of high electrical voltages (potential differences).

Section 7 - Machine Shop Operating Rules

Under no circumstances is Styrofoam, molding foam (for example **RenShape 460**), or similar material to be machined on any equipment in the Ware Lab. Doing so produces minute dust particles that will severely damage equipment.

1. **Machine Guards:**

Guards are available to assist in keeping the operator safe and should be in place anytime the machine is in operation. Removing guards from any equipment during operation will result in loss of Ware Lab access privileges. Guards used at Ware Lab consist of the following types:

- **A.** Fixed or enclosed – permanent part of machine, contain no moving parts, prevent everything but work piece from reaching point of operation. **Example:** sandblaster glass covers
- **B.** Interlocked – prevents operation of machine unless guards are in place.
- **C.** Adjustable – movable by operator to allow various sizes of material to be used on a single machine - most common in Ware Lab. **Examples:** band-saw, grinder, lathe, shearing machine
- **D.** Self-adjusting – guard opens as work piece is advanced, keeping point of operation only large enough to accommodate contacted material. **Example:** circular saw

2. **Safeguarding Devices:**

- **A.** Presence sensing (optical, electromechanical)
- **B.** Pullback cables (attached to operator)
- **C.** Restraint straps (on operator to a fixed point)
- **D.** Safety trip controls (pressure sensitive, tripwires)
- **E.** 2-hand controls/trips (contact pressure by both hands)
- **F.** Gates (moveable barrier, ex: Hurco CNC mill)
- **G.** Pressure mats (prevents operation if activated)

3. **Lockout/Tag-out:**

- **A.** Lockout/tag-out ensures that all hazardous energy sources of a machine have been de-energized and secured in a positive manner.
- **B.** This prevents injury while servicing the machine, removal of guards for specific cuts, or cleaning the machine.
- **C.** The only time lockout/tag-out does not apply is if the machine can be unplugged to perform tasks.

4. In Case of Emergency:

A. There are three (3) red buttons on the walls of the machine shop near exit that will shut off all machinery in the area. Lighting will remain on.
B. If an emergency arises during machine operation press one of these buttons before attempting to assist injured person(s).
C. A first aid kit and fire extinguisher are located by the machine shop door.
D. If there is an emergency in the shop – CALL 911!
E. There is a phone located by the window of the Machine Shop Supervisors office.

5. Grinder/Sander:

A. Bench rests on grinder **must be** 1/8'' from abrasive wheel.
B. Tongue guards on grinder must be positioned ¼'' from abrasive wheel.
C. **Never** remove grinder guard.
D. Make sure coolant is nearby to immerse hot parts.
E. If a wheel is damaged or defective, ask the shop supervisor to perform a ring test.
F. Carbide grinder is for sharpening carbide tools ONLY!!!
G. Aluminum should **not** be used on grinders **– it is too soft and clogs the wheel preventing it from working.**
H. Secure all parts with holding tools and against bench rests to prevent impact injuries.
I. Never leave a grinder, buffer, or sander unattended.

6. Band Saw:

A. The band saw has blades of different tooth pitch:

i. The small tooth blade is for thinner material
ii. The large tooth blade is for thicker material
iii. The rule of thumb is that you should have at least 3 teeth in the material during cutting.

USING THE WRONG BLADE WILL DAMAGE IT BEYOND REPAIR!!

B. Make sure the teeth are facing down in the cutting area before operating.
C. Change the speed of the blade according to the chart attached to the side of the band-saw.
D. Support part on either side of the blade during cutting using push blocks or metal support - **do not use hands on small parts!**
E. All Band-saw operating information can be found on side of band-saw.
F. For more information on band saw blades, see:

http://www.starrett.co.uk/support/Technical_Information/

7. Milling Machine (aka Mill):

A. Spindle must be OFF when changing GEARS (low/high).
B. Spindle must be ON when changing SPEEDS (RPM).
C. Make sure work piece is completely secure before machining.
D. Indicate the vise before using – use indicator to get vise side parallel to x and y axes'.
E. **If you take a vise off to accommodate a larger part, replace and re-indicate the part when you put it back within 0.002" for the next person to use!**
F. Do not over-tighten chuck in mill - press to "IN" only one or two quick times to get snug.
G. Mill Z-axis must be completely up before chuck can be removed.
H. Always clean up after use – vacuum table, behind table, sweep floor, wipe down with cloth.
I. **If the trash can is full at the milling machine, take it out!**
J. Do not contact the gear box rubber cover with the work piece or vice.
K. If damage occurs report it to the Ware Lab manager or shop supervisor ASAP!
L. Make sure that mill speed is at lowest gear setting before finishing work on a particular machine to prevent machine damage and operator injury for next person using mill!

8. CNC Mills and Lathe:

A. **DO NOT USE** Hurco or open CNC mills without first reading the operating manual or having someone familiar with the machine there with you. The Hurco milling machine operators manual is located in Appendix A of the policy manual.
B. Same set-up rules apply to CNC mills as to regular mills.
C. **If you take a vise off to accommodate a larger part, replace and re-indicate the part when you put it back within 0.002" for the next person to use!**
D. **DO NOT USE** the CNC lathe without reading the manual first or having someone familiar with the machine accompany you.
E. **DO NOT place large material blanks onto any CNC device due to excessive waste and potential for flying debris.**
F. Always clean up after use – vacuum table, behind table, sweep floor, wipe down with cloth.
G. **If the trash can at the CNC is full, take it out!**

9. Lathe:

A. Do **NOT** over tighten ANY nut on the lathe, particularly the tool post holder. **It will strip the nut!**
B. All handles should be returned to positions as shown once work is finished.

C. Clean all parts of machine after use. **If the trash can is full at the lathe, take it out!**

10. Shear Device:

Under NO circumstances is anyone other than the machine shop supervisor allowed to operate the plate shear device. Doing so could result in serious injury and/or damage to the machine.

11. General:

A. Bits and tools may be checked out from shop supervisor.
B. If you observe someone being unsafe either to themselves or to other students mention it to them politely but firmly. If they continue to act in an unsafe manor, report it to the Ware Lab manager or shop supervisor immediately.
C. Do not attempt to re-calibrate any component of machine shop equipment without the permission and supervision of the Shop Supervisor.
D. Follow proper mixing practices when adding cutting fluid to the machines. See the Shop Supervisor and/or the handout "Metalworking Fluids Mixing Practices" on Scholar (in the Resources section) for more information.

Section 8 – Potential Welding Shop Hazards

1. **Potential Injuries:**

   See **Section 6.1**.

2. **Severe Injuries** (in addition to those indicated in Section 6.2):

   A. asphyxiation
   B. welding fume fever
   C. lung cancer
   D. infertility

3. **Impact Hazards:**

   See **Section 6.3.**

Example of impact hazards include (in addition to those indicated in **Section 6.3**):

   A. Sander throwing part at foot or shin.

4. **Entanglement Hazards:**

   See **Section 6.4.**

5. **Sharp Objects Hazards:**

   See **Section 6.5.**

Section 9 - Welding Shop Operating Rules

1. **Lockout/Tag-out:**

   See **Section 7.3.**

2. **In Case of Emergency:**

   A. There is a fire alarm next to the rear door of the welding shop in case of emergency.
   B. A first aid kit and fire extinguisher are located along the front wall of the welding shop.
   C. If any danger is present, leave the area immediately. **Do not try to fix the problem yourself!**
   D. CALL 911! There is a phone located in the hallway across from the outside of the welding shop next to the white board, in front of the Ware Lab manager's office.

3. **Gas Cylinder Hazard Controls:**

   A. Gas cylinders are stored at high pressure levels

      i. Full oxygen tanks are at 2200 psi (at 70^{o} F, 21^{o} C)
      ii. Full acetylene tanks are at 250 psi (at 70^{o} F, 21^{o} C)

   B. Gas cylinders must be secured in a vertical position at all times.
   C. Caps should be in place when in storage, during transport, or when they are not expected to be used within 24 hours.
   D. Do not stand in front of a regulator when opening – it can blow to front or back causing serious injury.
   E. Never rely on the cylinder color to identify the contents – **read the label!**
   F. If the valve is damaged or a cylinder is knocked over it will either:

      i. spin in place (back away, do NOT attempt to stop cylinder from rotating) or
      ii. shoot straight (move away, do NOT attempt to stop cylinder from translating)

   G. If a tank is empty, change to a new tank and inform the shop supervisor by email.

4. **Worker's Actions** (in addition to those indicated in Section 3.10):

   A. Leather shoes or boots are required while welding, grinding or cutting.

B. Welding helmet with filtered lens are required while welding, tacking or plasma cutting. These are located in the shop or can be provided by the shop supervisor. These should be stored in the beige cabinet when not in use.
C. Long sleeves should be worn at all times while welding – jackets are available in the machine shop, and should be stored in the cabinet.
D. Leather gloves should be worn at all times while welding, and should be stored in the cabinet.
E. Long pants are required in the welding shop
F. Exhaust fans must be turned on when welding!

5. Grinder/Sander:

See **Section 7.5.**

6. Sandblaster:

A. Before starting, place work piece inside of the sandblaster through the small side door.
B. Lock small door.
C. Turn on light and fan.
D. Use permanent gloves (attached to sandblaster) while handling work piece and sandblasting gun.
E. Do **NOT** aim gun at clear plastic viewing window – **it will scratch the window and make it difficult to see the part.**
F. Keep gun at least 6 inches away from part to achieve an even finish.
G. If you are unfamiliar with the proper use of the sandblaster, practice with a spare piece before using on final work piece.

7. Sheet Metal Bender:

A. Sheet metal bender can be very hazardous if operator is not paying attention.
B. Maximum metal thickness is 10 gage - exact thickness in inches varies for different standard type:
- 10 gage for steel is 0.1345”
- 10 gage for galvanized sheet steel is 0.1382”
- 10 gage for zinc is 0.0200”, etc.

C. The bender is only for flat plate – **round material will damage the machine.**
D. Bending plates can be moved to accommodate larger or smaller pieces.
E. Metal will spring back a certain amount after bending, amount differs for thickness and metal type.

8. Plasma Arc Cutter/CNC Work Station:

A. Read user’s manual (on cart with computer) before using.
B. Check material to be cut to make sure it does not release hazardous fumes.

C. Computer cart must be **thoroughly cleaned and returned to CAD lab after each use** to avoid damage due to dust.
D. Welding helmet must be worn during operation (using a shade of ~8 or 9).
E. HVAC ventilation system must be on during use.
F. **Pull welding curtain closed during operation to avoid harming other students entering shop!**
G. Do NOT try to pierce more than 3/8 inch thick metal. You can cut thicker material, but you must start from an open edge or a pre-drilled hole. Trying to pierce thicker material will ruin the tip, shield, electrode, ceramic cup, and ohmic clip. This damage could amount to as much as $100 or so.
H. All but two of the settings (on the Machine Control and Height Control tabs) have been set properly. The ONLY two setting that you may need to adjust for ANY material that you cut are the following:
- Cutting Speed (on the Machine Control tab),
- Material Thickness (on the Height Control tab).

DO NOT adjust anything else!
DO NOT check or uncheck any of the check boxes

I. Feel free to use the PakMaster 75XL for plasma cutting by hand if you need it, but keep the tip approximately 3/16 inch above the workpiece while cutting. Do not let it touch the workpiece. That will ruin the tip.
J. Always use the downdraft table/air filtration unit
K. Spray a very light coat of antispatter on the torch tip before cutting. This will extend the life of the torch consumables.
L. Put your sheet metal drops away when you're done - do not leave sheet metal on the plasma table.

9. Oxy-fuel Safety:

A. Use only regulators that are provided.
B. Do not tamper with safety valves on cylinders.
C. Do not open the acetylene cylinder valve more than ¾ of a turn when turning the unit on.
D. Never use acetylene at line pressure above 15 psi. – **higher pressures can result in an explosion!**
E. Oxygen should never be used as compressed air.
F. Never use matches or a cigarette lighter to ignite the oxy-acetylene torch. Only use spark igniters.
G. When turning the torch off, always turn the flammable gas (acetylene) off first, then turn off the oxygen. This will prevent the torch from producing a large billowing flame which can be dangerous with large torch tips.
H. Be sure that cylinders are turned off and all valves are closed before leaving the gas welder.

I. Do not weld in the direction of the hoses – **this can damage them beyond repair.**
J. Hand tighten the welding tip/cutting torch on the torch body. Do not over tighten!
K. Regulators control the amount of gas leaving the tank during the welding process and are thread specific so they cannot be confused:

i. *Oxygen* regulators have *right* hand threads.
ii. *Acetylene* and *fuel* regulators often have *left* hand threads.

10. General:

A. Always wear protective clothing that is suitable for using welding equipment or plasma cutter.
B. Do not carry matches, butane or propane lighters, or other flammables in your pockets while welding.
C. Shield others from the light rays produced by arc welding. Keep the welding curtain in place at all times.
D. Never lay the electrode holder on the welding table or a grounded metal surface. Place it on an insulated hanger.
E. An electrode holder should never touch a compressed gas cylinder.
F. Never weld with the cables coiled over your shoulders.
G. Do not use cables with frayed, cracked or bare spots in the insulation.
H. Make sure that work area is well ventilated when using the plasma arc cutter.
I. Never breathe fumes when welding lead, cadmium, chromium, steel, manganese, brass, bronze, beryllium, zinc, or galvanized steel. These fumes are toxic and may cause sickness or death.
J. The operator should position himself/herself so there will be minimum exposure to fumes during the cutting process.
K. Fumes from the following metals can be toxic and in some cases fatal. Avoid cutting these metals:

i. antimony
ii. arsenic
iii. barium
iv. beryllium
v. cadmium
vi. chromium
vii. cobalt
viii. copper
ix. lead
x. manganese
xi. mercury
xii. nickel
xiii. selenium
xiv. silver

xv. vanadium

M. Turn down-draft system on to capture fumes
N. Never touch any parts on the plasma cutter that are electrically connected.
O. Hearing protection should be worn when operating the plasma cutter.
P. Make sure that others in the work area are protected from the plasma arc cutter rays and fumes.
Q. Always coil hoses and cords and store them off of the floor when not in use (this includes ALL welding cables for the TIG welder).
R. Do not place gas cylinders with flammable gas in the outside storage area. See Shop Supervisor for storage.
S. Flammables in the Weld Shop:
   a. Acetone (and other such flammables) must NOT be stored in the weld shop. When not in use, these materials must be removed from the weld shop and stored in a flammable liquid cabinet in the team's bay.
   b. When these materials are in the weld shop, no other work which throws sparks or involves an open flame (i.e. no grinding, cutting, MIG welding, etc) may be performed in that area. TIG welding is acceptable (if it is a necessary part of the process), but must be performed at least 6 feet from the location of the flammable substance.
   c. Appropriate gloves must be used when handling chemicals, but these gloves should not also be used for welding.

Section 10- Multi-Use Bay

Any team needing access to the Multi-Use Bay must…

A. pass all provisions of **Section 2.1**,
B. be approved by the Ware Lab manager, and
C. be working on a junior or senior level engineering project.

Once approved, a combination to the two bay door locks will be issued to the team leader by the Ware Lab manager and are to be shared with necessary team members only. Combination locks for lockers are available from the shop supervisor for project material storage only. Area **MUST BE** kept clean and organized at all times so other teams can use the bay. Both bay doors **MUST BE** locked after use!

Section 11- Ware Lab Parking Regulations

1. Student Team Member Parking

Current Virginia Tech student parking permits are necessary for teams needing to park personal vehicles in the service spaces at the back of the facility. Time limits of no more than 30 minutes are allowed for loading and unloading of project related materials and equipment. Student permits are required 24 hours a day, seven days a week. **Parking is for the purpose of loading and unloading materials related to Ware Lab student projects ONLY.**

Note: Parking MUST be in a designated service parking spot in the rear of the Ware Lab. Vehicles parked along Old Turner Road in the vicinity of Ware Lab are subject to citation. Vehicles can be parked in front of the garage loading dock door but for no longer than 30 minutes to avoid a parking citation. Rented vehicles need to have temporary permits issued by Parking Services in order to park legally behind Ware Lab.

2. Private service Worker and Contractor Parking

Private contractors (including maintenance personnel) need to report to the Virginia Tech visitor's center to obtain the proper parking permits prior to working at the Ware Lab. The Visitor Center's web site is at:

http://www.facilities.vt.edu/tcs/parking/visitors.asp

Section 12 – Use of Golf Cart and Fork Lift

Ware Lab has a gas powered golf cart that is available for special events on campus and is used by college of engineering staff only. Students are not permitted to use the golf cart.

Ware Lab has a fork lift that may be operated by certified Virginia Tech staff member only. **Students are not permitted to operate the fork lift under any circumstance.** If the fork lift is needed to load or unload project material contact the Ware Lab manager or shop supervisor at least 24 hours prior to needing the fork lift. The fork lift is available during normal Ware Lab operating hours of 9:00 am to 4:00 pm, Monday through Friday.

Section 13 – Ware Lab Public Outreach and Email Communication with Teams

As a member of a Ware Lab team, part of your responsibility is to participate in various public outreach events. These events serve the purpose of exposing your team's project to members of the greater engineering and public communities. In addition, over a thousand people tour the Ware Lab each year in groups from K-12, community colleges, universities, research facilities, and industry. Ware Lab is often cited as one of the most memorable parts of any Virginia Tech visit. Visitors are impressed with the level of sophistication of the projects conducted here and the professional attitudes of students.

Often during the year, you will be asked to participate is public and university events, or to have one or two members of your team be present in the project bay for certain lab tour events. You are encouraged to wear shirts with team logos and be prepared to spend about three to four minutes talking about yourselves (academically), your project, and your team's competition. The time spent with a group depends on its size and the amount of time allocated for the tour. Discussing your work with the public is an excellent way to sharpen public speaking skills and also gets the word out about your project. Many sponsors and potential students (and families) visit the Ware Lab throughout the year and, without exception, they are very interested in what you have to say.

In addition, throughout the year team leaders will receive emails from the Ware Lab manager about public events, tours, changes in policy, etc. Emails are sent directly to the team leaders and copied to each faculty advisor. **It is the responsibility of the team leader to forward all emails to their particular team list serves unless instructed to do otherwise. Any miscommunication with other team members about important events, policy notices, etc. due to not receiving an email from the Ware Lab manager will be sole responsibility of the team leader(s).**

Section 14 – Effective Information Transfer

Information transfer involves passing important knowledge gained from participation in a project and competition to succeeding teams. Information transfer is essential for maintaining team continuity and to prevent teams from “reinventing the wheel” each year.

It is the responsibility of each Ware Lab team to maintain a well-organized and complete log of activities associated with design, construction, testing, and implementation of project deliverables. Items to include in a paper and/or electronic project folder include, but are not limited to:

- team meeting minutes
- concept drawings and sketches
- CAD drawing files
- FEA files (if applicable)
- CFD files (if applicable)
- travel logs
- expense reports
- interim and final reports and presentations
- sponsorship information
- observations made at competitions

Effective information transfer between each succeeding team is essential due to the complexity of the projects conduced at Ware Lab. Many team participants are graduating seniors who currently convey important information to the succeeding teams via team meetings held during the academic year. Due to increasing project complexity there is a growing need for a structured, systems approach to information transfer. Electronic storage of data allows for efficient archiving and transfer of relevant information to succeeding teams resulting in more efficient use of time and resources.

In performing effective information transfer, one approach involves the establishment of a junior or sophomore level team that is involved in the overall design process and performs preliminary virtual and physical prototyping of the competition deliverable. As team members move into their junior or senior year they become part an advanced team, who perform final construction and testing of the car for competition. With this arrangement, direct, real-time sharing of information occurs during the academic year at scheduled information sharing sessions. Other Ware Lab teams, if they have not done so already, should consider adapting this or similar techniques. By applying a structured, consistent, approach to information transfer, a more efficient and complete sharing of knowledge results that is increasingly critical to team success.

Section 15 – Yearly Ware Lab Stipend

Each year, Ware Lab teams are awarded a stipend to assist with start-up expenses such as team recruitment, equipment and materials, and miscellaneous project expenses. Dollar amounts are based on needs, team size, academic credit received, and academic level of team members. In order to receive a stipend teams must submit the following items:

1. <u>Summary Report of Previous Year's and Current Year's Team Activities</u>

This should not be a long report but a concise description of what your team did last year and plans to do this year.

Procedure:

Report must be submitted electronically as a single PDF in the Scholar *Assignment* link. Report MUST follow proper technical writing format as taught in your engineering design course(s) (see *Appendix A* if you need a recommended guideline for this).

The report must include:

A. title page with:

a. project name
b. date of submission
c. new team leader(s)
d. faculty advisor(s)
e. departmental affiliation(s)
f. sponsoring organization(s)
g. course CRN(s) (if applicable)

B. project description (one brief paragraph)

C. number of students involved in project last year and this year with breakdown of academic level and major (one brief introductory paragraph with one table)

D. students credit breakdown for last year and this year: (1) capstone design, (2) independent study, or (3) other – with brief explanation, (one brief introductory paragraph with one table for last year and one table for the current year)

E. competitions participated in and those you plan to participate in this year, including dates and outcomes out of total number of competitors and breakdown of component scores (e.g. *2nd place in design or out of 45 competitors*) (all one brief paragraph)

F. description of the nature of the competitors (e.g. all from Virginia, region(s) of U.S., U.S. & Canada, etc.) (one brief paragraph)

G. approximate team project funding amount and source(s) for last year and current year(one brief paragraph)

H. current needs for additional space and/or equipment that might be appropriately provided in the Ware Lab, tentative project budget for current year (through summer of current year), and amount of Ware Lab stipend requested by your team (all in one brief paragraph)

2. Project Poster

A. no larger than 36" in one direction (24"x 36" preferred, 36" x 36" acceptable)

B. poster sent to plotter (located in *Ware CAD/CFD/FEA Lab*). **Plotting ink is very expensive so make sure your poster is free of mis-spellings, typos, poorly pixilated photos, etc.** To determine the quality of photos having potential pixilation problems, zoom into the photo part of your posted to 100% or larger. This will allow poor resolution to show better prior to plotting

C. ALL old posters are to be removed from outside of project bay before placement of new poster

D. new poster placed outside of Ware Lab manager's office in Ware 103 once plotted so backing board can be applied

E. poster need to be displayed outside of project bay once Ware Lab provides backing board and hooks

F. If you want to get your team poster(s) plotted and mounted quickly a good local vender for this is:

CBI – Cardinal Blueprinters, Inc
3913 South Main St., Blacksburg VA 24060
540-951-4303
cbi-sales@dts-repro.com

3. Video and Photos

A. one project video (at least 1 minute in length but no more than 3 minutes) developed from the previous year submitted to the team folder in Scholar. I will use these during tours in the flat screen display in the showroom and in one of the four photo presenters located in the window of my office,

B. two or three high resolution photos in jpg format (may be the same one used in the summary report) showing your project being constructed and your team at competition.

Section 16 – Ware Lab Tour Guide Policies

Being a Ware Lab tour guide is a great opportunity to practice important public speaking skills, meet new people and learn about projects going on at the lab! If you are interested in giving tours please contact the Ware Lab manager, Dewey Spangler, at spangler@vt.edu. **Once you are approved to give tours, please look over the following tour guide policies:**

1- Before giving any tours on your own, you should watch me or another trained tour guide give at least one tour. This will count as your training. You can always watch another tour if you think you need more orientation.

2- Once you are trained I will start emailing you requests to do tours with the day, time, name, contact and size of the group. I try to keep size to 25 or less due to the confined space of the lab areas.

3- **Please** do a **"reply all"** indicating your availability for giving a tour. Nothing fancy here, just an "I can take this tour". This keeps me and the other tour guides in the loop.

4- Once you commit to a tour, please email the contact person for the group and let them know that you can take the tour and confirm the day and time. **Always be courteous and professional in replies!** Please copy me on the email so I will know that you have confirmed with the group.

5- Dress code is neat casual (clean tee-shirts, jeans okay if in good condition (no large holes), tennis shoes ok if in good condition, Hokie gear- a big plus!)

6- At the beginning of the tour introduce yourself (first and last name), your major and academic level. Folks are always interested in these things and it helps break the ice! Ask if anyone in the group has even been to Ware Lab before and if so when they were they here. This also helps everyone to relax a little.

7- Determine how long the group has to stay. Some stay the full 45 minutes, some stay only 20 minutes. If they stay 35 minutes or longer you should be able to take them to the Human Powered Sub bay in the basement after you finish touring the main floor. Please do this if time allows since this is an impressive thing to see! The HPS bay can be accessed by returning to the showroom area of the lab, exiting through the side entrance (in the stair well) going down the steps, along the building, to the lower parking lot. One in the lot, take a right and the HPS lab is the second door on the right. It is marked with a big sign. Your card should access the lab. If it does not, email me ASAP with your last name and student number and I will set this up with Hokie Passport. If the lab supervisor or I are around we can let you in. If not, just explain to the group that card assess is still being set up.

8- If there are any student team members in the lab when you give a tour ask them to introduce themselves (first and last name, engineering major), and to briefly (about four or five minutes) explain their project and what they do on the team. Students do a great job at this and it gives you a break during the tour. If a student goes longer than about 5 minutes and the time for the tour is running out, politely let him or her know that you need to move on. Always thank them for their time. If you have an extended period of time for the tour and/or there are only a few teams in the lab, team members may talk longer than 5 minutes.

9- If any tour group is disrespectful to you or any of the team members contact the supervisor or me immediately. If we are not around tell the group in a professional way that you have taken time out of your busy schedule to give them a tour. Tell them if they have any questions or comments to raise their hands first and then speak one at a time. If that does not work end the tour and instruct the group to leave the building. Most folks who tour the lab are great to work with and really appreciate that you are giving them a tour so this is usually not a problem (if ever).

10- At the end of the tour, either at the HEVT bay (for tours less than 35 minutes) or HPS bay (tours longer than 35 minutes) thank the group for listening and ask them if they have any questions. They are welcome to take with them one of the smaller Ware Lab brochures (the one with Hokie Bird on the front) and a Ware Lab DVD. We have a lot of these and they are located in the dispenser next to the stair well exit, beside the showroom. You can also tell them to go to http://www.eng.vt.edu/warelab and at the bottom of the front page is an electronic version of our full brochure, the DVD and an interactive 2010 edition of *Engineering Now* magazine giving a lot of detail about the lab and its projects.

11- Remember to have fun and enjoy the experience!

Section 17 – “A Death in the Lab” – REQUIRED READING!

All persons using the Ware Lab facility need to read the following tragic story of a Yale student who had safety training but did not follow rules on proper use of a machine lathe.

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A Death in the Lab

Fatality adds further momentum to calls for a shake-up in academic safety culture.

Richard Van Noorden

Fellow students hold a vigil for Yale undergraduate Michele Dufault. THE YALE DAILY NEWS

In the early hours of 13 April, undergraduate students working at Yale University's Sterling Chemistry Laboratory made a shocking discovery. There in the lab's machine shop was the dead body of 22-year-old undergraduate student Michele Dufault, her hair tangled in a lathe. She had apparently died of asphyxiation in an accident described by Richard Levin, president of Yale in New Haven, Connecticut, as a "true tragedy".

Within days, federal health and safety officials had started to investigate. Details are scarce, but it is already clear that Dufault was not inexperienced with the equipment; she had taken a training course and had used the lathe safely many times before, according to fellow physics student Joe O'Rourke. She was, however, working late at

night and probably alone (a speculation that Yale would not confirm) — circumstances that were not unusual at the machine shop, says O'Rourke.

Around the United States, laboratory directors and safety officers immediately checked their own policies on working practices in machine shops. But the accident has also heightened wider concerns about the ever-present tension between research freedom and safe working conditions in academia. And it underscores the slow pace of change since another high-profile laboratory fatality led to similar soul-searching less than three years ago.

In late 2008, 23-year-old research assistant Sheharbano Sangji sustained horrific burns in a lab fire at the University of California, Los Angeles (UCLA), and died of her injuries 18 days later. Sangji's death — in very different circumstances from Dufault's — resulted in federal fines for the university and a rapid toughening of safety policies there. On 30 March, UCLA unveiled its latest safety initiative: a new Center for Laboratory Safety, which is billed as the first in the United States to measure the effectiveness of safety policies and develop ways to improve scientists' approach to safety. More widely, Sangji's accident acted as a lightning rod for demands to improve standards across the United States.

Sheharbano Sangji (left) and Michele Dufault. FACEBOOK

Yet for all this attention, health and safety experts say that they have not seen a significant shift in the behaviour of bench scientists or the attitudes of lab heads, who are in the best position to improve safety culture. "It's very difficult to change principal investigators' attitudes," says James Gibson, UCLA's director of environmental health and safety. All too often, researchers in laboratories around the country still work alone, and without proper supervision or protection. "In many cases, academic freedom is more important than safety," says Jim Kaufman, president of the Laboratory Safety Institute in Natick, Massachusetts.

Chemical focus

Although such concerns apply across academia, accidents in chemistry laboratories have drawn the most scrutiny in recent years. A year after Sangji's death, Preston Brown, a graduate student in chemistry at Texas Tech University in Lubbock, lost three fingers of his left hand during a dangerous experiment. Brown was grinding up chunks

of nickel hydrazine perchlorate — using a hundred times the recommended amount — when it detonated.

Unusually, the US Chemical Safety Board (CSB) — a body that usually investigates large industrial accidents such as refinery explosions — stepped in. For the first time ever, it said it would review academic laboratory safety. At an August 2010 meeting of the American Chemical Society in Boston, Massachusetts, CSB chairman Rafael Moure-Eraso said that the board had gathered media reports of around 120 university chemistry laboratory accidents since 2001, and concluded that "safety practices at US universities leave a lot to be desired".

Chemistry labs have been a particular focus of concern because the most dangerous procedures in other sciences tend to have more detailed safety protocols, says Peter Reinhardt, head of environmental health and safety at Yale University. "Using radioactive materials or biological materials is much more stringently regulated," he told Nature (speaking before Dufault's accident). "The big gap is hazardous chemicals in laboratories."

Rick Danheiser, an organic chemist at the Massachusetts Institute of Technology in Cambridge who chairs the chemistry department's health and safety committee, agrees that some labs' safety standards are too lax. But "there are chemistry departments with very strong safety programmes, and there's a whole range of laboratories in between", he says.

Neal Langerman, who runs the consulting company Advanced Chemical Safety, based in San Diego, California, is more strident about the extent of the problem. "I have come to the conclusion that most academic laboratories are unsafe venues for work or study," he wrote in a 2009 opinion column in the Journal of Chemical Health and Safety. He now says that, despite the recent accidents, he has not noticed a significant change in chemists' attitude to safety.

US scientists are undeniably much safer today than before swathes of occupational health legislation arrived in the 1970s, along with a new watchdog agency, the federal Occupational Safety and Health Administration (OSHA). Further improvements came in 1991, when OSHA stipulated that each chemistry lab should prepare a 'chemical hygiene plan' — effectively a handbook detailing safety protocols and emergency procedures — although these requirements are rarely enforced by inspections.

The US Bureau of Labor Statistics says that the rate of recordable incidents in scientific research and development services has fallen from 2.1 per 100 full-time employees in 2003 to 1.2 in 2009. But the government does not track major accidents or near misses specifically in academic laboratories. "Anecdotally, most people agree that university labs have more frequent and more frequently serious accidents than industry," says Dorothy Zolandz, director of the National Academies Board on Chemical Sciences and Technology.

Researchers often point out that industry is in a better position than academia to keep safety standards high because it has a clear hierarchy of power, fewer inexperienced students, and accountability to management. One of the clearest difference lies in lone working: surveys by the American Chemical Society last year suggest that 70.5% of faculty and 52.1% of graduate students often or occasionally work alone in laboratories, something that is forbidden in industry.

Safety officers and experienced chemists say that good laboratory safety relies on far more than regular inspections. What's key, says Tom Welton of Imperial College London, is that the group's research leader accepts unequivocal responsibility for the safety of everyone doing science in the laboratory, building a culture where researchers instinctively have safety foremost in their minds.

Evidence presented at a US National Research Council meeting on laboratory safety in November 2010 backs up Welton's point. Ron Zanoni, manager of occupational safety at international chemicals giant Arkema, based in Colombes, France, showed a 2004 survey that found case injury rates ranging from 7.8 to 0.8 per year at Arkema's various US sites. The differences correlated well with working relationships and top-down leadership engagement at different sites, Zanoni says. Improving safety leadership at labs with poor records had reduced injury rates by 2007.

“Changing the culture is really going to be a long-term challenge.”

As UCLA has found, it can be hard to change researchers' mindsets, even after a death on campus. Over the past two years, the university has ramped up laboratory safety regulations, training and inspections. But Nancy Wayne, a physiology professor on the board of the new laboratory safety centre, says researchers at UCLA do not always appreciate the tougher regime, sometimes seeing environmental inspectors as 'police', rather than partners in improving standards. "Changing the culture is really going to be a long-term challenge," says Gibson. Some professors, he says, have even questioned the need for flame-resistant lab coats — a bitter irony given the circumstances of Sangji's accident.

She was using a syringe to draw reactive t-butyl lithium from a bottle when it burst into flames, setting her clothes alight. She was not wearing a lab coat. Since then, the California Division of Occupational Safety and Health has agreed fines with UCLA of around US$70,000 for safety violations. Sangji's supervisor, Patrick Harran, declined Nature 's request for an interview. The Los Angeles district attorney is still reviewing Sangji's case, and has not yet decided whether to press criminal charges against either Harran or UCLA. If this resulted in a conviction, "the rules change completely right then and there", says Langerman. "All of a sudden, if you hurt somebody badly, you may face felony charges."

In the United Kingdom, the threat of legal action has proved to be a powerful incentive for change. Around 25 years ago, an explosion in a chemistry laboratory at Sussex University in Brighton shot a piece of metal into a student's abdomen. The student

eventually recovered, but the government's Health and Safety Executive prosecuted Sussex University for negligence. The episode had a profound effect on safety standards in Britain, says Welton. Today, British researchers are required to write down risk assessments before every experiment, something that is not required in the United States.

"I think that it will take a professor being punished, perhaps unfairly, to really engender change on the part of academia overall," says chemical-safety blogger Chemjobber, an industrial synthetic organic chemist in the United States. But funding agencies could also play a part. The CSB, for example, is considering recommending that grant applications should contain specific safety-training requirements.

"I think in the long run, the CSB recommendations, a possible new OSHA lab standard, and input from the American Chemical Society will result in a modification of the regulatory climate," says Langerman. But scientists should not wait for those changes before taking the initiative on safety, he adds.

"Members of the academic community have unique freedoms that are denied to industry," he says. "They then have a unique responsibility to behave in a manner that supports the freedom they are given."

Appendix A – Recommended Technical Writing Guidelines

These recommendations are to serve as a guide and are not to override technical report writing guidelines required by your engineering faculty advisor(s):

1. **Title Page –** per instructions given in Section 15

2. **Table of Contents -** lists the location, by page number, for the start of each section of the report in order of appearance. The appendices are placed at the end of the report in the order that they are referred to in the main body.

3. **Report-** This is a brief description of the activities of the Ware Lab team for the previous year. See Section 15 of this policy manual for contents necessary in order to receive a stipend.

4. **References -** This should be a list of any sources you used for any and all aspects of the project. Do not use footnotes to indicated references. Use a set of braces [ ] containing the number of the reference. Complete source information is required. In short, an interested researcher can find an article, text, paper, etc. referenced in the team's report using the information given. References are numbered and the number assigned to a given source is used to cite the source within the body of the team's report. The numbered sources are listed in order of their citing in the body, followed by any general sources that were not specifically cited in the report. You may use any acceptable format for the references as long as it is consistent!

15. **Additional standard practices in technical writing:**

    a. All work is to be done in a consistent font (usually Arial or Times New Roman) and 12 pt letter size. Do NOT mix fonts in text and tables or figure headings. Use one or the other font consistently

    b. Use 1" top, bottom, and right margins. Use a 1.25" left margin for binding in a three ring binder.

    c. Tables are to be centered in the report and their titles are centered and placed at the TOP of the table.

    d. Titles are to be meaningful. Say "**Table 1 – Team Population for 2011 FSAE Team**" instead of just "**Table 1 – Team Population**".

    e. Tables are to be referenced in the body of the text BEFORE they appear in the report.

    f. Figures are to be centered in the report. Titles are to be centered and placed at the BOTTOM of their corresponding figure. Figures are to be referenced in the

body of the text BEFORE they appear in the report. Figure titles are to be meaningful as well (see item d).

g. Use third person instead of first person: (“The frame sub-team performed FEA for the A-arms.”, not “We performed FEA for the A-arms”).

h. Use active voice instead of passive voice: (“The team determined that an important design criteria is durability.”, not “Durability was determined to be an important design criteria by the team.”)

Appendix B – Operating Procedure for the *Hurco* CNC Milling Machine

Under no circumstances is Styrofoam, molding foam (for example RenShape 460), or similar material to be machined on the Hurco CNC milling machine. Doing so produces minute dust particles that will damage oiled surfaces on the equipment that must move relative to one another.

1. Turn machine on
2. Press F8 exit
3. Press MANUAL
4. Press F1 (Tool in Spindle)
5. Press 0 (no tool) and press ENTER
6. Press F7 (Reset Servos and Spindle)
7. Hit Power then press START
8. Press F8 (Calibrate Machine) and Press START : Table should move , if not reset servos by pressing F7)
9. Press F5 to warm up machine then START
10. Insert disk containing program
11. Press F5 to stop warming up machine
12. Press AUXILIARY, then Press F6 (Change Editor)
13. Select F1 (for inches)
14. Select F1 (Storage Function)
15. Select F6
16. Select F1 (Floppy drive)
17. Select F1 (Reprogram from disk)
18. Pick program and then Press ENTER (Check the volume occupied by disk, should be above 80%)
19. Press MANUAL to mount tools in
20. Go ahead and put tools in
21. Press F1 (Toll in spindle); Press 1 then Press ENTER for tool 1
22. Press INPUT
23. Press F2 (Toll setup); Press 1 then ENTER, Press ENTER until you get to zero calibration
24. Zero your tool Z position
25. Press F7 (Set toll zero) and Press MANUAL
26. Press F2 (Change tool); put tool number 2 and Press ENTER
27. Press AUTO then START
28. Press Tool Changer MANUAL; Load tool and Repeat step 23 to 28
29. Press INPUT and F1 (Part setup)
30. Jog to find part zero
31. Press F7 for X and Y, (NO Z)
32. Hit GRAPHICS and Press System Mode AUTO
33. Press F6 (Check for errors)
34. Press F8 and Press START